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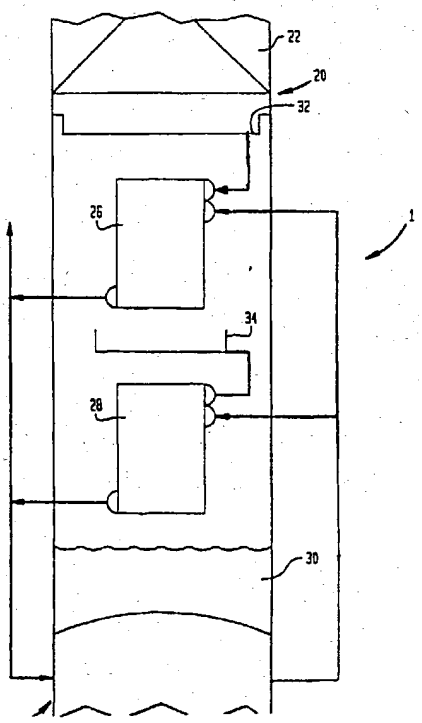
(54) Method of operating the lower pressure column of a double distillation column

(57) An ascending vapour phase is initiated within the lower pressure column 20 of a double distillation column 1 by vaporising a descending liquid phase at a column location situated between mass transfer elements 22 and a sump region 30 of the lower pressure column 20. The liquid phase is vaporised within two or more down flow reboilers 26 and 28 fed with the liquid phase so that the unboiled liquid from one (26) of the down flow reboilers is fed to the other (28) of the down flow reboilers, thereby to cause vaporisation to be distributed between the down flow reboilers 26 and 28. The down flow reboilers 26 and 28 are operated such that sufficient vaporisation occurs to produce a predetermined liquid-vapour ratio at the column location between the transfer elements 22 and the sump 30 without the requirement of recirculating sump liquid to prevent dry out.

FIG.



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Description

[0001] The present invention relates to a method of operating the lower pressure column of a double column distillation unit.

[0002] Various mixtures are distilled within double distillation column units having a higher pressure distillation column operatively associated with a lower pressure distillation column in a heat transfer relationship. The mixture to be distilled is processed within the higher pressure column and then is further processed within the lower pressure column. A typical example of such distillation is the low temperature rectification of air. In the typical example, a stream of compressed and purified air is cooled to a temperature suitable for its rectification. The cooled air stream is introduced into a higher pressure distillation column to produce a nitrogen overhead fraction and a bottom oxygen-enriched liquid fraction. The bottom fraction is introduced into a lower pressure column for further separation to produce oxygen and nitrogen products. The oxygen product can be taken in liquid and/or vapour state.

[0003] In both the higher and lower pressure columns, ascending vapour phases and descending liquid phases of the mixture to be distilled are produced. These vapour and liquid phases are contacted by mass transfer elements such as structured packing, random packing or trays. In the lower pressure column, nitrogen vapour from the overhead region of the higher pressure column is condensed by heat exchange with the liquid fraction produced in the lower pressure column. The vaporisation of the liquid in the lower pressure column initiates formation of the ascending vapour phase while the nitrogen condensate is recirculated back to both the higher and lower pressure columns to initiate formation of the descending liquid phases. Alternatively, a liquefying air stream can be used to vaporise the bottom liquid fraction in the lower pressure column.

[0004] In order for the overhead nitrogen vapour fraction separated in the higher pressure column to condense the liquid oxygen fraction separated in the lower pressure column, a temperature difference must be maintained therebetween. In general, the smaller this temperature difference, the more efficient the air separation. It has been found that down flow reboilers provide small temperature difference. This is because the lower the temperature difference to be maintained between the nitrogen to be condensed versus the oxygen to be vaporised, the lower the pressure within the higher pressure column and, hence, the lower the pressure to which the air need be compressed.

[0005] The down flow reboilers that are used for such purposes are also referred to in the art as falling film devices in that a falling film of the liquid is initiated within heat exchange passages. As is well known in the art, down flow reboilers or falling film devices consist of a plurality of parallel plates to form the heat exchange passages. Generally, sheets of corrugated fin material are located within the heat exchange passages to increase the surface area of the heat exchanger and therefore the heat transfer capability of the heat exchanger.

[0006] A draw back to the use of down flow reboilers, particularly in air separation, is that heavy contaminants such as hydrocarbons concentrate in the liquid oxygen to be vaporised. Such reboilers are operated to vaporise only part of the liquid oxygen so as to prevent dryout of the heat exchange passages and potentially hazardous collection of hydrocarbons therein. Unvaporised liquid is returned from the column sump by means of a pump. The disadvantage of such operation is not only that a pump must be supplied, operated and powered, but also additional pumping energy imparted to the sump liquid must be compensated for by increased refrigeration and therefore increased power outlays in operating the plant. These extra requirements reduce the advantages of the down flow reboiler.

[0007] It is an aim of the invention to overcome or ameliorate this problem.

[0008] In accordance with the invention, a method is provided for operating a lower pressure column of the double distillation column unit. The method comprises initiating an ascending vapour phase within the lower pressure column by vaporising a descending liquid phase at a column level situated between mass transfer elements used in contacting the vapour and liquid phases and a sump region of the lower pressure column. The liquid phase is vaporised within at least two down flow reboilers fed with the liquid phase such that unboiled liquid from one of the down flow reboilers is fed to another of the down flow reboilers, thereby to cause vaporisation to be distributed between the two down flow reboilers. The at least two down flow reboilers are configured and operated such that sufficient vaporisation occurs to produce a predetermined liquid-vapour ratio at the column location without the sump liquid from the sump region being recirculated back to the least two down flow reboilers.

[0009] As is apparent, by distributing the vaporisation of the liquid within multiple down flow reboilers, all of the liquid that is required to be vaporised within the down flow reboilers can be vaporised without the necessity of there being any pumps to recirculate liquid for vaporisation.

[0010] The method according to the invention will be described by way of example with reference to the accompanying drawing which sheds schematically each of a double rectification column for the separation of air.

[0011] With reference to the Figure, a double distillation column unit 1 has a higher pressure column 10 and a lower pressure column 20. Lower pressure column 20 contains mass transfer elements 22 which can be structured packing, random packing or trays. Mass transfer elements 22 function to bring the ascending vapour phase into intimate contact with the descending liquid phase as a known, predetermined ratio of liquid to

vapour. Thus, if the liquid vapour ratio is 1.4, then approximately 1.4 units of liquid must be descending against 1 unit of vapour ascending.

[0012] In order to initiate formation of the ascending vapour phase, two down flow reboilers 26 and 28 are illustrated. The liquid that is not condensed within down flow reboilers 26 and 28 collects within a sump region 30 of lower pressure distillation column 20.

[0013] Liquid descending within lower pressure column 20 is collected within a liquid collector 32 where it is partially vaporised within the down flow reboiler 26. The liquid not vaporised is caught within collector 24. Liquid caught in collector 34 is then routed to down flow reboiler 28. The liquid is then partly vaporised within down flow reboiler 28 and the remaining liquid collects within sump region 30. Alternatively, both down flow reboilers can be one unit with appropriate vapour disengagement and liquid redistribution within the same unit.

[0014] Nitrogen-rich vapour overhead from higher pressure column 10 is fed to down flow reboilers 26 and 28, in parallel, where such nitrogen-rich tower overhead condenses to produce liquid nitrogen. Part of the liquid nitrogen is returned to higher pressure column 10 and another portion is used as reflux to lower pressure column 20. Such reflux initiates formation of the descending liquid phase.

[0015] Down flow reboilers 26 and 28 are designed in a known manner to function at a specific duty so that vaporisation of the down flowing liquid is distributed. Thus, assuming a liquid to vapour ratio of 1.4 the down flow reboiler 26 can be designed so that for each 1.4 units of liquid that are introduced from collection 32, 0.7 units vaporise and 0.7 units are caught in collector 34. The 0.7 units that are collected within collector 34 are then routed to down flow reboiler 28 designed so that half of the 0.7 units vaporise and the remaining half collects within the sump region 30. This produces a total vaporisation of about 1.05 units to produce the required liquid to vapour ratio. Therefore, the required vaporisation occurs without there being any pumping of liquid from sump region 30.

[0016] An oxygen product stream is withdrawn from the sump 30 in liquid state. If desired, a pump (not shown) may be used for this purpose. The pump may be used to raise the oxygen product stream to a delivery pressure. If desired a part or all of the oxygen product may be vaporised.

Claims

1. A method of operating the lower pressure column of a double distillation column unit, said method comprising:

   initiating an ascending vapour phase within the lower pressure column by vaporising a descending liquid phase at a column location situated between mass transfer elements used in contacting said vapour and liquid phases and a sump region of said lower pressure column;

   said liquid phase being vaporised within at least two down flow reboilers fed with said liquid phase such that unboiled liquid from one of said down flow reboilers is fed to another of said down flow reboilers, thereby to cause vaporisation to be distributed between said at least two down flow reboilers;

   the at least two down flow reboilers being operated such that sufficient vaporisation occurs to produce a predetermined liquid-vapour ratio at said column location without sump liquid from said sump region being recirculated back to said at least two down flow reboilers.

2. A method according to claim 1, wherein the double column is employed to separate air and a nitrogen-rich vapour is removed from the higher pressure column of the double column and is condensed against the vaporising liquid phase.

3. A method according to claim 2, wherein said liquid-vapour ratio is about 1.4.

4. A method according to any one of the preceding claims, where a stream of said sump liquid is removed from said sump and is taken as product.

FIG.